P4 PRODUCTION
SOUTHEAST IDAHO MINE-SPECIFIC SELENIUM PROGRAM

PRE-2004 DOCUMENTS AND DATA REVIEW AND SUMMARY FOR THE HISTORIC P4 PRODUCTION PHOSPHATE MINES, CARIBOU COUNTY, IDAHO

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Introduction

The deliverable provides a list of pre-2004 documents – plans and reports – containing information relevant to the soil, terrestrial ecological, and aquatic ecological media for P4 Production's site-specific investigations and engineering evaluation and cost assessments for the Ballard, Henry, and Enoch Valley mines. The documents are listed by medium; thus, a given document may appear more than once. A brief summary of the relevance of each major report is provided. Each document listed herein is provided as a pdf file in the enclosed compact disc. The associated pre-2004 data (actually, data through spring 2006) for the three media of interest herein is also provided in the enclosed compact disc table format as Excel files.

The purpose of this list and document and data files is to facilitate a discussion of data gaps for the three environmental media of interest. Data gaps for surface water & sediment were discussed in March 2007. As a result of that discussion the surface water investigations were extended through 2008, after which data gaps will be reassessed. Data gaps for geology & groundwater were discussed in June 2007. As a result, P4 Production expanded the scope of their 2007 hydrogeology investigation and reported the results, including an updated assessment of data gaps, in February 2008. Additional hydrogeology investigation efforts are planned during the 2008 field season, including a Geoprobe program, the plan for which has been submitted, reviewed, refined and, in January 2008, resubmitted for another round of agency review. A planning memorandum for this year's drilling program will be submitted shortly.

While surface water & sediment and geology & groundwater are not the focus of this deliverable, it is acknowledged that identification of some data gaps and consequent data collection activities for soil, terrestrial ecological, and aquatic ecological media may well result in the need for further supportive data collection in one or both of the other media. For example, if further fish investigation is deemed necessary, it is hard to conceive of investigating fish without also investigating surface water & sediment (as well, potentially, as other media or sub-media).

One other medium, facilities, is also included in the site investigations, but is not addressed separately herein. Rather, facilities investigation data gaps have been addressed, as needed, during discussions of other media. For example, the need for mine mapping enhancements was addressed during the discussion of geology & groundwater data gaps.

This deliverable is focused on pre-2004 efforts – i.e., those undertaken before the agencies and P4 Production entered into the consent order governing the mine-specific investigations and evaluations/assessments. This focus is because all efforts undertaken from the time the order was signed have been reported and summarized in the revised draft *Preliminary Investigation Evaluation Summary*, submitted for agency review in November 2007.

Following the list of documents by medium, with brief summaries for major reports interspersed, is a list of pre-2004 data, and an updated presentation of the conceptual understanding of the three mines that is focused on the three media of interest. The original conceptual understanding was presented in Subsection 3.2.2 in the final comprehensive site investigation work plans, which were approved in March 2004.

This should be considered a work in progress. The amount of relevant documentation produced since 1997 is considerable, and P4 Production, the agencies, and MWH are working to identify effective and efficient ways to make such documentation readily available. Recently, for example, parties expressed interest in placing all documents and data files on a readily accessible server, similar to internet access using Microsoft SharePoint. Reports and data are currently available on a web site constructed and maintained by the Idaho National Laboratory and Idaho State University, but apparently accessing documents on the INL/ISU web site is a bit cumbersome. A focused, well organized, and easily accessible online digital library, if one can be set up and maintained affordably, would provide all stakeholders with an advantageous information resource.

P4 Production looks forward to scheduling a meeting with the agencies to discuss data gaps in the media addressed herein.

Medium-Specific List of Relevant Pre-2004 Documents

Soil

Report: Montgomery Watson, 1999, *Final 1998 Regional Investigation Report: Southeast Idaho Phosphate Resource Area Selenium Project*, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: 1998 RI Report (1999).pdf]

Plan: Montgomery Watson, 1998 Regional Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

> The study area was divided into three districts, roughly – west (Gay Mine), central (upper Blackfoot and Bear river watersheds), and east (Smoky Canyon Mine). Three waste rock dumps from each district were randomly selected to preliminarily characterize dumps in each district; two of the three dumps in the central district are at Monsanto mines. Of the target analytes – selenium, cadmium, manganese, nickel, vanadium, and zinc – selenium had the highest ratio of dump average to background (undisturbed Phosphoria Formation outcrop) average, and, by far, the highest ratio of maximum observation to background average.
>
> Selenium soil (and vegetation) concentrations differ significantly by district; thus, only central district results should be considered relevant. However, the mean reported for all nine dumps for the entire study area is 43 mg/kg dw, far above a US Forest Service proposed benchmark.

Report: MWH, 2001, *Enoch Valley Mine Waste Rock Dump Characterization, Caribou County, Idaho,* prepared for Monsanto, Bellevue, WA.
[File: 2000 EVM WRD Characterization (2001).pdf]

Plan: Montgomery Watson, 1998 Regional Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

> The soil on the Enoch Valley Mine dump was characterized by means of stratified random sampling. Strata included topsoil stockpile, topsoil cover (shallow and deep), brown shale, cherty shale, black shale, and background (a nearby, undisturbed Phosphoria Formation outcrop). Analytes included total selenium, cadmium, manganese, nickel, vanadium, zinc, calcium, iron, potassium, magnesium, and sodium, as well as extractable selenium.
>
> The average concentration of total selenium was significantly higher than background in all strata except for the stockpiled topsoil; there was little meaningful difference amongst the elevated strata. The variability in extractable selenium was higher, with all strata except stockpiled topsoil and brown shale being greater than background on average. Average total selenium concentrations for all elevated strata are well above proposed USFS reclamation benchmarks.
>
> Background cadmium variability is high; thus, none of the strata were found to be higher than background. Stockpiled topsoil is the only stratum with above-background concentrations of manganese. For nickel all but stockpiled topsoil and shallow topsoil cover are elevated. Brown, cherty, and black shales are elevated in regard to vanadium. And, only cherty shale contains elevated zinc.
>
> A principal components analysis of the soil and vegetation data shows total selenium in soil and vegetation defining the first principal axis. (The PCA is displayed in black & white on the accompanying pdf file, and background and cherty shale appear to have the same symbol; but, they are easily differentiated by their distinct clusters on the graph.)

Report: MWH, 2002, *Final – Spring 2001 Area-Wide Investigation Report, Southeast Idaho Phosphate Resource Area Selenium Project,* prepared for the Idaho Mining Association Selenium Committee, Bellevue, WA.
[2001 Spring AWI Report (2002).pdf]

Plan:
[File: In Preparation]

Data Validation Summary: [In Preparation]

At the direction of IDEQ, three non-random samples were obtained from each waste rock dump for all mines included in the regional investigation. Thus, three samples were obtained at Ballard Mine, three at Henry Mine, and two and Enoch Valley Mine. The results lie within the range of values observed in dump soils during the 1998 regional investigation, but, because they were non-random, in fact, biased, they cannot be regarded as representative. Per the agency, only black shales were sampled. Such shales contain the most contaminants but represent a mere fraction of the surface of most dumps.

Report: MWH, 2002, *Final – Summer 2001 Area-Wide Investigation Data Summary, Southeast Idaho Phosphate Resource Area Selenium Project,* prepared for the Idaho Mining Association Selenium Committee, Bellevue, WA.
[File: 2001 Summer AWI Data Summary (2002).pdf]

Plan: Montgomery Watson, 2001. Summer 2001 Area-Wide Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Included in report.

This work was done at the request of IDEQ to support the completion of their area-wide ecological risk assessment. Both upland and riparian soils were characterized – background and impacted. Background upland stations are located on undisturbed Phosphoria Formation outcrops; impacted upland stations are located on waste rock dumps within the upper Blackfoot River watershed. Background and impacted riparian stations are located above and below influences of phosphate mining, respectively.

Analytes include the target elements selenium, cadmium, nickel, vanadium, zinc. It also includes aluminum, antimony, arsenic, barium, beryllium, boron, chromium, copper, fluoride, lead, manganese, mercury, silver, thallium, organic carbon, conductivity, and pH. To our knowledge these data have never been thoroughly evaluated.

Report: E.A. Dolan, P.B. Stenhouse, and W.E Wright, 2003, *Selenium in the Topsoil: A Response to USFS Topsoil Salvage Guidelines*, prepared by MWH for the Society of Environmental Toxicology and Chemistry Annual Meeting, Bellevue, WA.

There is no need for topsoil salvage guidelines based on either total or extractable soil selenium, even in seleniferous soil from Phosphoria Formation outcrops, as the refractory selenium in such soil is not bioavailable to vegetation. Unnecessary disposal of topsoil is considered an adverse environmental impact, and the withdrawal of topsoil salvage guidelines is recommended.

Terrestrial Ecology

Report: Montgomery Watson, 1999, *Final 1998 Regional Investigation Report: Southeast Idaho Phosphate Resource Area Selenium Project*, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: 1998 RI Report (1999).pdf]

Plan: Montgomery Watson, 1998 Regional Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

> Along with background and waste rock dump soil, as mentioned above, associated vegetation samples were collected and analyzed for the same set of target analytes: selenium, cadmium, manganese, nickel, vanadium, and zinc. Significant differences by district exist, so only those samples from the randomly selected central district dumps are relevant, but the overall mean for the entire study area is three times the suggested reclamation benchmark of 5 mg/kg dw.
>
> Selenium and vanadium are the two target analytes most elevated in dump vegetation relative to their respective background, but the ratio of vegetation-to-soil is, by far, highest for selenium.

Report: Montgomery Watson, 2000, *1999 Interim Investigation Data Report*, prepared for the Idaho Mining Association Selenium Committee, Bellevue, WA.
[File: 1999 Interim Investigation Data Report (2000).pdf]

Plan: Montgomery Watson, 1999. Interim Field Sampling Plan, 1999 Interim Regional Investigation/Management Study: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

> This document provides an interim report on the bird egg study (Ratti et al., 2002), and the first year of a two-year elk study conducted by IMA and IDFG (Wright et al., 2002); see summaries of these studies below. The results of a cattle study not reported elsewhere are also provided.
>
> Twenty steers experimentally grazed on four different plots during a nine week period over the summer were sent to the University of Idaho feedlot for a selenium depuration study. The plots included enclosures on three waste rock dumps at Henry Mine, as well as a non-seleniferous control pasture. Five steers

from each plot were sent to the University after the 15 on seleniferous pasture were returned to a non-seleniferous pasture for 30 days. This schedule of nine weeks of montane pasture followed by 30 days of lowland pasture then shipment to a feedlot is representative of how cattle are normally grazed in the area.

The duration of time in the feedlot was a normal 120 days. During this time blood samples and tissue biopsies were taken over time, but have not been reported. (The sample size of tissue biopsies was too small to allow for meaningful detections of selenium.) At the end of the feedlot period, the steers were slaughtered and post-mortem samples of skeletal muscle, liver, kidney, and heart were obtained. Muscle samples from steers kept on seleniferous pasture had selenium concentrations up to an order of magnitude greater than those observed in the control steers, up to 1.0 mg/kg dw and 0.10 mg/kg dw, respectively.

Unlike elk, where selenium concentrates in the liver more so than in the muscle, in cattle muscle concentrated it more than did the internal organs. This may be due to the relatively short exposure duration to seleniferous pasture of only nine weeks for the cattle, whereas elk have the potential (albeit low, due to the relatively small portion of their habitat that is seleniferous) to be exposed year around. On the other hand, while elk graze over a large home range, these steers had nothing but seleniferous forage for their entire period of exposure, so some sort of adaptation may have occurred.

The beef generated from this study was donated by IMA to the Food Bank of Idaho. To ensure the safety and health of those consuming the beef, the US Food Safety Inspection Service participated and, with the help of the US Food and Drug Administration, developed an interim beef standard of 1.0 mg/kg ww. Two carcasses of the 20 (of the 15 exposed to seleniferous pasture) were slightly over the interim standard at 1.1 and 1.2 mg/kg ww, and were thus disposed of. That 13 of 15 carcasses were deemed safe to consume holds hope that grazing practices could be modified somehow to prevent accumulation of selenium to levels that are undesirable.

Report: MWH, 2001, *Enoch Valley Mine Waste Rock Dump Characterization, Caribou County, Idaho,* prepared for Monsanto, Bellevue, WA.
[File: 2000 EVM WRD Characterization (2001).pdf]

Plan: Montgomery Watson, 1998 Regional Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

Like soil, the herbaceous edible vegetation soil on the Enoch Valley Mine dump was characterized by means of stratified random sampling, with vegetation

samples being co-located within the same quadrats as those from with soil samples were obtained. The strata included topsoil stockpile, topsoil cover (shallow and deep), brown shale, cherty shale, black shale, and background (a nearby, undisturbed Phosphoria Formation outcrop). Analytes included total selenium, molybdenum, cadmium, aluminum, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium, and zinc.

The average concentration of selenium was significantly higher than background in all strata except for the stockpiled topsoil; as with soil, there was little meaningful difference amongst the elevated strata. Average selenium concentrations for all elevated strata are above the proposed USFS reclamation benchmark of 5 mg/kg dw.

Molydenum in vegetation displays the same pattern as does selenium – all strata except stockpiled topsoil above background. Cadmium concentrations do not vary across strata – all, including background, cannot be differentiated. Most other vegetation analytes also do not show departures from background, with the exception of nickel (all strata but stockpiled topsoil elevated)

The ratio of copper to molybdenum, if low, can point to a potential for molybdenum toxicity. Molybdenosis is a form of copper deficiency, caused by molybdenum complexing with copper, reducing the latter's bioavailability. The Cu/Mo is less than 2 for all strata but background and stockpiled topsoil, thus indicating a potential problem for any livestock that might graze the dump in the future.

The principal components analysis of the soil and vegetation data shows total selenium in soil and vegetation defining the first principal axis, and selenium in vegetation defining the second.

Presentation: W.E Wright, A. Dukelow, and B.A. Narloch, 2002, *Elk Tissue Quality Within the Southeast Idaho Phosphate Resource Area,* prepared by MWH for the Society of Environmental Toxicology and Chemistry Annual Meeting, Bellevue, WA.
[File: 2002 Elk Tissue Quality (2002).pdf]

Pattern and cluster analysis succeeds at differentiating between background and selenium-elevated elk. About 30% of the elk in the study area have elevated tissue selenium, predominantly in liver rather than skeletal muscle. The risk to those who eat elk liver of acute nausea is low; there is no risk associated with chronic consumption. The risk of chronic selenosis in the elk themselves is low. While there is significant elevated exposure to selenium, there is little consequence to either the elk or the people eating them.

Report: MWH, 2002, *Final – Summer 2001 Area-Wide Investigation Data Summary, Southeast Idaho Phosphate Resource Area Selenium Project,* prepared for the Idaho Mining Association Selenium Committee, Bellevue, WA.
[File: 2001 Summer AWI Data Summary (2002).pdf]

Plan: Montgomery Watson, 2001. Summer 2001 Area-Wide Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Included in report.

> This effort was described above under Soil. Terrestrial ecological submedia sampled were vegetation, invertebrates (both aboveground and soil-burrowing), and rodents, in upland and riparian habitats. The analyte list was very similar to that for soil. These data were collected at the direction of IDEQ to support their regional ecological risk assessment.
>
> IMA evaluated the data to see if abundant soil and vegetation data could be used to predict concentrations of selenium in worms (i.e., soil-burrowing invertebrates), insects (i.e., aboveground invertebrates), and rodents. Statistically significant regressions were found that can be used to make all three of these predictions.

Report: Tetra Tech EM Inc., 2002, *Final Area Wide Human Health and Ecological Risk Assessment: Selenium Project, Southeast Idaho Phosphate Mining Resource Area,* prepared for Idaho Department of Environmental Quality, Boise, ID.
[Folder: 2002 Area Wide Risk Assessment]

Plan: [Not Available]

Data Validation Summary: Tetra Tech did not validate the data used.

> Based on this assessment, the agency risk concluded that regional human health and population-level ecological health risks are unlikely, and that there is no need for time-critical removal action in the study area.

Report: E.O. Garton, R.V. Vasterling, J.T. Ratti, 2002, *Population-Level Assessment Models for Red-winged Blackbird and American Robin Metapopulations in Southeast Idaho,* prepared for MWH, University of Idaho, Moscow, ID.
[File: 2002 Bird Population Models (2002).pdf]

> Four species of birds were selected as study-area indicator species to evaluate potential impacts of selenium releases on at the population level. Data from Ratti et al. (2002) is used as input to the models. Due to drought conditions sufficient data for two of the indicator species – American coot and yellow-headed blackbird – could not be obtained, but the remaining two species function as diverse indicators, as the American robin feeds primarily on upland food sources, while the red-winged blackbird feed primarily on aquatic food sources. Modeling demonstrated that if all mine-impacted habitat were remediated to unimpacted conditions, the population size of red-winged blackbirds would not change, while the population size of American robins would decrease (i.e., American robins prefer disturbed habitat).

Ecological risk can be meaningfully assessed only if the assessment is done at the population level of ecological organization or higher. Garton et al. demonstrate that such assessments are feasible and, in the case of birds, that selenium releases from phosphate mines are causing no significant adverse population-level impacts.

Report: J.T. Ratti, A. Rocklage, E.O. Garton, 2002, *Analysis of Selenium Levels in Bird Eggs and Assessment of the Effects of Selenium on Avian Reproduction in Southeast Idaho,* prepared for MWH, University of Idaho, Moscow, ID.
[File: 1998-2001 Avian Reproduction (2002).pdf]

Bird egg selenium data was collected over three years along with bird reproduction (i.e., hatching and fledging) success rates. Elevated levels of selenium are observed in eggs laid in areas downstream or in the vicinity of phosphate mines, but no adverse impact to reproductive success could be discerned. In fact, increased reproductive success appears to be associated with increasing selenium egg concentration in red-winged blackbirds at concentrations well above suggested remediation thresholds.

Report: L. Kuck, 2003, *An Evaluation of the Effects of Selenium on Elk, Mule Deer, and Moose in Southeastern Idaho,* prepared for MWH, Star, ID.
[File: 2003 Evaluation of Se Effects on Big Game (2003).pdf]

Elk, mule deer, and moose have adjusted to most phosphate mining activities except for habitat loss, but fortunately that loss to date has not been large and can be mitigated. Elk and moose populations have steadily increased since open-pit phosphate mining began in the region. Although about 30% of elk have elevated tissue selenium, the strong and vigorous nature of the herd indicates the health of the herd has not been jeopardized.

Report: L. Kuck, 2003, *The Management of Big Game Populations, Their Habitat, and Selenium in Southeast Idaho,* prepared for MWH, Star, ID.
[File: 2003 Mgmt of Big Game Populations (2003).pdf]

Seven potential management options are offered. They pose opportunities for "treatability" investigations.

Aquatic Ecology

Report: Montgomery Watson, 1999, *Final 1998 Regional Investigation Report: Southeast Idaho Phosphate Resource Area Selenium Project*, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: 1998 RI Report (1999).pdf]

Plan: Montgomery Watson, 1998 Regional Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.

[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

> The initial sampling of fish under the southeast Idaho selenium program was in fall 1998, when three stations were sampled, two of which in the upper Blackfoot River watershed. The third station is located near Smoky Canyon Mine in the eastern district, but was sited for use as a control station. One of the two stations in the upper Blackfoot – East Mill Creek downstream of North Maybe Mine – is not and cannot be influenced by any of P4 Production's mines.
>
> The remaining station – Blackfoot River upstream of Wooley Range Ridge Creek, ST026, i.e., downstream of The Narrows) – is in a different watershed than Henry Mine and the northwestern portion of Enoch Valley Mine, is upstream of Ballard Mine, and is downstream – quite far downstream – from the southeastern portion of Enoch Valley Mine. Thus, the results for the three fish obtained from ST026 say little about P4 Production's potential impacts. However, the average selenium concentration in Yellowstone cutthroat trout fillets for ST026, 1.2 mg/kg ww (approximately 5 to 6 mg/kg dw) was not discernibly different from that observed, 1.3 mg/kg ww, in the control brown trout fillets from the eastern district.

Report: Montgomery Watson, 2000, *1999 Interim Investigation Data Report, Southeast Idaho Phosphate Resource Area Selenium Project,* prepared for the Idaho Mining Association Selenium Committee, Bellevue, WA.
[File: 1999 Interim Investigation Data Report (2000).pdf]

Plan: Montgomery Watson, 1999. Interim Field Sampling Plan, 1999 Interim Regional Investigation/Management Study: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for the Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

> This document provides a report on the cutthroat trout genetic study (Powell, 2000) and an interim report on the cutthroat feeding study (Hardy, 2003); see summaries of both these reports below. It also provides the report of the initial egg viability study performed on the Henry's Lake and upper Blackfoot River eggs used as the source of fish for the feeding study.
>
> While egg selenium was higher in the Blackfoot River eggs than in the Henry's Lake eggs (4 to 7 mg/kg dw vs. 1 mg/kg dw), hatching success was equally high in both groups, and the birth defect rate was equally low – an order of magnitude and statistically significantly lower than the threshold of concern.

Report: M.S. Powell, 2000, *Genetic Variation Among Cutthroat Trout (Oncorhynchus clarki) in the Blackfoot River, Idaho*, prepared for Montgomery Watson by University of Idaho Fish Culture Experiment Station, Hagerman, ID.
[File: 2000 Genetic Variation Among Cutthroat Trout (2000).PDF]

> Cutthroat trout obtained from Henry's Lake and the upper Blackfoot River were both determined to be Yellowstone cutthroat trout, unhybridized with rainbow trout. No evidence of survivorship bias was observed in the trout obtained from the upper Blackfoot River.

Report: Montgomery Watson, 2001, *Draft 1999-2000 Regional Investigation Data Report for Surface Water, Sediment and Aquatic Biota Sampling Activities, May – June 2000,* prepared for the Idaho Mining Association Selenium Committee, Bellevue, WA.
[File: In Preparation]

Plan: Montgomery Watson, 1999. 1999-2000 Regional Investigation Sampling and Analysis Plan: Southeast Idaho Phosphate Resource Area Selenium Project, prepared for Idaho Mining Association Selenium Subcommittee, Bellevue, WA.
[File: In Preparation]

Data Validation Summary: Data validation summary reports not generated, but USEPA data validation criteria were met.

> The aquatic ecological submedia sampled during the regional investigation of 1999 and 2000 were periphyton, plankton, macrophytes, benthic macroinvertebrates, forage fish (on a whole-body basis), and salmonids (trout fillets). The target analytes for all these submedia were selenium and cadmium.
>
> In periphyton, selenium concentrations increase in creeks below phosphate mines in the fall, at the end of the growing season. This may render fall periphyton a good potential long-term monitoring indicator. No pattern in the periphyton community structure that could be attributed to selenium was observed – only an apparent difference between creek and river communities, which is likely due to differences in flow magnitude. River stations look to have more diatoms and green algae than do creeks.
>
> Due to an absence of a control site, plankton data from Blackfoot Reservoir is difficult to interpret; but, cadmium is not an issue and selenium concentrations vary considerably. Selenium in the upper reservoir, where inputs from phosphate mine releases are being received, may be higher than in the lower reservoir. This might be interpreted as an observation of the reservoir removing selenium from the water column, but the variability in lower reservoir observations encompass those in the upper reservoir. From a community structure perspective, lower reservoir samples appear to have rotifers and cladocerans playing a more important role, and diatoms a less important role, than in samples obtained from the upper reservoir. This does not seem to be significant relative to phosphate mining.

As with periphyton, differences in macrophyte quality between controls and affected stations are larger in the fall, at the end of the growing season, than in the spring. Macrophytes in some creeks downstream of phosphate mines are much higher in both selenium and cadmium in the fall.

Benthic macroinvertebrate samples from some creeks below phosphate mines can have elevated selenium and cadmium, but most samples in various aquatic settings, including most stream stations below mines, are no different than controls. With regard to community structure, stream and reservoir stations are clearly different, as is to be expected due to the difference in habitat types as defined by flow or no flow. But, interestingly, all stream stations have a healthy insect fauna, and creek and river stations are virtually all healthier in this regard than are the control creeks. In fact, the first principal axis of the benthic macroinvertebrate community is defined by a greater presence of caddisflies, mayflies, and beetles. This is an assemblage indicative of clean-water, and is regarded as a healthy food base in trout streams.

Forage fish show few samples with selenium concentrations higher than controls, but many with higher cadmium concentrations. In salmonids the only station noticeably greater than control conditions is, as in fall 1998, East Mill Creek, a station physically isolated from any P4 Production mine. Of interest is that spring fillet selenium concentrations appear to be somewhat higher than those in the fall, which corresponds with higher selenium concentrations in the water column during spring runoff. Also, concentrations in the fish from the Blackfoot Reservoir are all low, indicating an absence of significant adverse impact in that body of water, which appears to function as the ultimate sink of all mining-related selenium released in the upper Blackfoot watershed.

Report: Tetra Tech EM Inc., 2002, *Final Area Wide Human Health and Ecological Risk Assessment: Selenium Project, Southeast Idaho Phosphate Mining Resource Area,* prepared for Idaho Department of Environmental Quality, Boise, ID.
[Folder: 2002 Area Wide Risk Assessment]

Plan: [Not Available]

Data Validation Summary: Tetra Tech did not validate the data used.

Based on this assessment, the agency risk concluded that regional human health and population-level ecological health risks are unlikely, and that there is no need for time-critical removal action in the study area.

Report: R.W Hardy, 2003, *Effects of Dietary Selenium on Cutthroat Trout (*Oncorhycus clarki*) Growth and Reproductive Performance*, prepared for MWH, University of Idaho Fish Culture Experiment Station, Hagerman, ID.
[File: 2003 Effects of Dietary Se on Cutthroat Trout (2003).pdf]

This document reports on the longest feeding trial to determine the effects of dietary selenium ever taken on fish of any species. Two groups of Native

Yellowstone cutthroat trout – one from Henry's Lake, the other from the upper Blackfoot River – were used for the study.

The initial step of the study was an egg viability study. Eggs collected from both sources were incubated until hatched to determine the birth defect rate, the most sensitive effect selenium toxicity has on fish. Fish hatched from these efforts were divided and raised under different dietary treatments, each with a different amount of selenomethionine (the bioavailable form of selenium found in the aquatic food chain) added to the diet. At the end of the two-year feeding trials, the fish within each treatment were bred and the resulting eggs subjected to another egg-viability study to determine birth defect rates.

The initial egg viability study showed no unacceptable birth defect rate in upper Blackfoot River cutthroat, despite selenium being elevated during spring runoff, at times above the state's cold water biota standard, in the river. During the feeding trials, the fish at all levels of dietary selenium (from a 1 mg/kg control up to as high as 11 mg/kg) grew at rates greater than do cutthroat raised at state and federal hatcheries. From the literature acute toxicity was anticipated at the highest treatment, but no toxicity – acute or chronic – was observed, either during the two-year growth period or the final set of treatment-specific egg viability studies.

Whole body and egg selenium levels increased with increasing selenium in diet up to a point, then appear to level off. At the end of the overall study a depuration assessment was conducted in which it was found that those cutthroat exposed to the higher levels of dietary selenium are able to excrete selenium at a higher rate than those exposed to lower levels. The cutthroat adapt to elevated selenium exposure by increasing their selenium excretion rates, thus preventing further accumulation during growth and depurating faster once exposure ceases.

This study shows that levels of selenium in most of the upper Blackfoot watershed are not sufficiently high to affect cutthroat growth, survival, or reproductive performance.

Updated Conceptual Understanding of the Contamination Concerns at Ballard, Henry, and Enoch Valley Mines

The following discussion presents, in brief, P4 Production's current conceptual understanding of the manner in which source contaminants may potentially impact various receptors on or near the historic phosphate mines While selenium, and, to a lesser extent, various other metals are the focus of this investigation, the discussion herein is focused on selenium, which is the most significant contaminant.

The discussion herein addresses potential human, ecological, and agricultural impacts. Environmental media of interest (i.e., facilities, soil, groundwater, surface water, sediment, terrestrial biota, and aquatic biota) within each of the five main categories of a site conceptual understanding (i.e., contaminant source, release mechanism, transport pathway, exposure route,

and receptor) may be presented separately to provide greater detail for a particular medium or group of media, or combined to streamline duplicate information.

Source

- Selenium in interburden and overburden found primarily in waste rock dumps is the ultimate source. The waste rock placed in external and internal rock dumps at Ballard, Henry, and Enoch Valley mines. Black shales, and, to a lesser extent, brown and cherty shales, are the primary geologic members of these waste rock piles that contain the selenium-enriched material.
- For surface water, groundwater contaminated by the source functions as a secondary source.
- For riparian soil, sediment derived from waste rock is a secondary source..
- For aquatic biota, sediment and surface water function as secondary sources.
- For terrestrial biota, dump soil, riparian soil, and surface water function as secondary sources.
- For humans, secondary sources are livestock, elk, and fish.

Release Mechanism

- Weathering: fragmentation of interburden and overburden and subsequent exposure to air results in oxidation of reduced selenium on increased surface areas; precipitation leaches and mobilizes oxidized surficial selenium, primarily during spring runoff. Oxidation also occurs through contact with surface water and shallow groundwater.

Transport Pathways

- Leaching – Selenium in the source is mobilized initially by vadose zone leaching.
- Groundwater flow – Once contamination is introduced to an aquifer by leaching of the source in the vadose zone, it can be transported horizontally off site via groundwater.
- Surface water runoff – Surficial contamination at the source can be transported to on-site or adjacent ponds via runoff; during large precipitation or snowmelt events such transportation could extend to nearby streams.
- Biotic uptake – Plants take up contamination from impacted soil via their roots; subsequent animal ingestion of plants can introduce contamination into the entire food chain.

Exposure Routes

- Human receptors – Ingestion of biota, e.g., fish, cattle, and elk.
- Ecological receptors – Ingestion of biota, and, for aquatic biota, immersion in surface water.
- Agricultural receptors – Ingestion of plants and surface water.

Receptors

- Human – Miner/rancher/hunter/fisherman; from a human perspective the maximally exposed receptor of potential concern, for chronic exposure, is a phosphate miner who happens to run a ranch and hunt and fish locally and consume his game meat and trout.
- Ecological – Elk grazing waste rock dumps. Song sparrow, American robin, black-tailed jack rabbit, red-winged blackbird, mallard, raccoon, and mink inhabiting waste rock dumps or riparian habitat on or below waste rock dumps. Yellowstone cutthroat trout inhabiting streams below waste rock dumps.
- Agricultural – Sheep, horses, and cattle that graze waste rock dumps or consume water from ponds on or adjacent to waste rock dumps..

Medium-Specific List of Relevant Pre-2004 Data Tables

The following list of media represents the enclosed historical data tables which encompass all of the data collected during each of the aforementioned investigations. Please note that some media contain post 2003 data. These results are included not only because this is how our database is set up, but also, any discussion of data gaps or future sampling needs should take this existing data into consideration.

Soil

Table 1	Upland Soil
Table 2	Upland Soil– Enoch Valley Mine
Table 3	Riparian Soil

Terrestrial Ecology

Table 4	Cattle
Table 5	Eggs
Table 6	Elk
Table 7	Riparian Vegetation
Table 8	Small Mammals
Table 9	Terrestrial Invertebrates
Table 10	Upland Vegetation

Table 11 Upland Vegetation– Enoch Valley Mine

Aquatic Ecology

Table 12 Benthic Macroinvertebrates
Table 13 Fish- Salmonids
Table 14 Fish- Forage Fish
Table 15 Macrophytes
Table 16 Periphyton
Table 17 Plankton